Appendix 2.7

Task 2.7: Water and Wastewater Treatment Plant Energy Optimization Evaluations

Submitted by:

Electric Power Research Institute

Palo Alto, California

Submitted to:

California Energy Commission

Sacramento, California

January 2002

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This report summarizes the findings of four energy studies conducted for EPRI, Southern California Edison, and the California Energy Commission.

This report is a corporate document and should be cited in literature in the following manner:

Summary Report for California Energy Commission Energy Efficiency Studies, EPRI, Palo Alto, CA: 2001. WO-6710.

ACKNOWLEDGEMENTS

The authors of this report would like to acknowledge the advice and assistance of the following persons:

Ray Ehrhard, John Murphy, and Kim Shilling of the EPRI Community Environmental Center at Washington University in St. Louis, Missouri.

David Perkins, technical expert of the EPRI Community Environmental Center.

Jeff Thuevret, Dee Cutino, Julie Labonte, and Alan Wong of the City and County of San Francisco and Oliver Kesting and Terry O'Sullivan of the Hetch Hetchy Bureau of Energy Conservation

Alec Brok, Albert Cheng, and Ricardo Pacheco of Metropolitan Water District and John Cooper, Ezell Culver, David Dean, Sean McCann, and Dale Hills of the Joseph Jensen Filtration Plant.

Dave Livingston, Jim Chen, Dave Stoops, Dave Mullaney and the staff of Union Sanitary District's wastewater treatment plant.

Ron Matheson and the staff of Vallejo Sanitation and Flood Control District's wastewater treatment plant.

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APPENDIX 1

PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research.

What follows is the final report for the **Water and Wastewater Demonstration Projects in California, WO-6710,** conducted by the **HDR Engineering, Inc.** The report is entitled *Summary Report for California Energy Commission Energy Efficiency Studies*. This project contributes to the **[PIER Program Area]** program.

EXECUTIVE SUMMARY

This report summarizes the findings of four separate energy assessments conducted at water and wastewater treatment plants in California. The plants evaluated included:

- San Francisco's Harry Tracy water treatment plant
- Metropolitan Water District's Jensen filtration plant
- Union Sanitary District's wastewater plant
- Vallejo Sanitation and Flood Control District's wastewater plant.

The purpose of the assessments is to identify opportunities to reduce energy consumption within the facilities and electrotechnologies that could improve the treatment process. The objective is to develop energy conservation measures to obtain the potential reductions and to evaluate the benefits of any electrotechnologies cited. The State of California benefits by the conservation of natural resources, reduction in pollution, minimized costs, and improved quality of treatment which thereby protects the environment. Eleven energy conservation measures (ECMs) at the water plants and 12 at the wastewater plants were identified through this project. These ECMs are estimated to save 8,533,854 kWh annually, which produces a cost savings of approximately $564,580. The ECMs are summarized below in Table 1.

Table 1. Summary of ECMs

Type of ECM	Number	Energy Savings (kWh)	Annual Cost Savings	Potential Rebates	Estimated Capital Cost	Recommended
Lighting Retrofits	5	51 kW 402,924 kWh	$27,180	$39,826	$74,000	YES
Energy Management System	3	420 - 480 kW 0 kWh/yr	$37,300		$65,000	YES
Load Shifting	4	501 kW 58,500 kWh/yr	$49,800	5,625	$3,000	YES
Equipment Modifications	4	362 kW, 941,810 kWh/yr	$54,800	$114,595	$50,250	YES
HVAC Changes	1	0 kW, 72,000 kWh/yr	$3,700		$2,000	YES
Operational Changes	2	75 kW 803,000 kWh	$44,800	$35,640	$30,000	YES
Modify NPW System	2	19 kW 762,120 kWh	$42,000	$91,090	$42,000	YES
Cogen Changes	1	600 kW 4,600,000 kWh	$254,000	$180,000	$205,000	YES
Permit Changes	1	127 kW 893,500 kWh	$51,000	$80,415	$150,000	YES
Total of Recommended ECMs			**$564,580**	**$547,191**	**$621,250**	

ABSTRACT

Energy assessments were conducted at two water and two wastewater treatment plants in California. The purpose of the assessments was to identify energy conservation measures and electrotechnologies that could reduce energy consumption or improve the treatment process. Eleven energy conservation measures at the water plants and twelve at the wastewater plants were identified. These measures are estimated to save 8,533,854 kWh annually, which produces a cost savings of approximately $564,580. These measures could be implemented for approximately $621,250. This project has shown energy assessments to be an effective way to reduce electrical demand and costs at municipal water and wastewater facilities. It is recommended that new studies be conducted at other facilities throughout the state to further reduce electrical demand and conserve our natural resources.

INTRODUCTION

This project involved four separate energy assessments conducted at water and wastewater treatment plants in California. The plants evaluated included:

- San Francisco's Harry Tracy water treatment plant
- Metropolitan Water District's Jensen filtration plant
- Union Sanitary District's wastewater plant
- Vallejo Sanitation and Flood Control District's wastewater plant.

The purpose of the assessments is to reduce electrical demand in the water and wastewater treatment plants evaluated. The objective is to develop energy conservation measures to achieve the reduction in electrical demand and to evaluate the benefits of any electrotechnologies cited.

This report summarizes the four assessments, which are included in the appendices.

PROJECT APPROACH

Each of the facilities assessed in this project were visit by the project team members. During the site visits the project team met with the plant staff for an orientation, a site tour, and to gather historic plant data. From discussions with members of the staff, the data collected, and the observations made from the tour, energy conservation measure (ECMs) were developed. A report evaluating the ECMs and the team's recommendations was then written for each facility.

PROJECT OUTCOMES

Water Treatment Plants

The Harry Tracy water treatment plant uses conventional flocculation/sedimentation with filtration and ozone to treat an average flow of 56 mgd. Raw water is pumped from the Hetch Hetchy water system into the plant and treated water flows out by gravity. The Jensen water plant treats an average daily flow of 200 mgd with a total plant capacity of 750 mgd. The treatment process also uses conventional flocculation/sedimentation with filtration and disinfection. Both raw and treated water flow by gravity, which results in a low unit energy consumption. Table 1 summarizes the energy consumption and cost for each plant.

Table 1. Energy Summary for Water Treatment Plants

	Jensen	Harry Tracy
Annual Plant Production	73,637 Mgal	20,587 Mgal
Average Daily Flow	200 mgd	56 mgd
Annual Energy Cost	$446,559 (8.3¢/kWh)	$556,707 (6.05 ¢/kWh)
Total Identified Savings	$68,200 (15%)	$45,800 (8%)
Annual Energy Consumption	5,404,000 kWh	9,199,755 kWh
Billing Demand	800 kW – 1,120 kW	1,280 – 2,410 kW
Specific Unit Energy Consumption	74 kWh/Mgal	446 kWh/Mgal

The energy conservation measures (ECMs) recommended for each water plant are summarized in Table 2. Eleven ECMs were recommended for implementation. The ECMs include three lighting retrofits to improve efficiency and control, an energy management systems, load shedding three systems during peak hours, modifications to improve the equipment efficiency of three processes, and an HVAC change to reduce cooling. The ECMs identified could result in a reduction of over 1,250,000 kWh annually, which would save over $132,000.

Table 2. Summary of ECMs for Water Treatment Plants

Type of ECM	Number	Energy Savings (kWh)	Annual Cost Savings	Potential Rebates	Estimated Capital Cost	Recommended
Lighting Retrofits	3	47 kW 267,624 kWh	$18,540	$24,942	$53,943	YES
Energy Management System	1	100 kW 0 kWh/yr	$12,300		$25,000	YES
Load Shifting	3	426 kW 0 kWh/yr	$44,900		$3,000	YES
Equipment Modifications	3	321 kW, 911,880 kWh/yr	$53,100	$111,902	$49,250	YES
HVAC Changes	1	0 kW, 72,000 kWh/yr	$3,700		$2,000	YES
Total of Recommended ECMs			**$132,540**	**$136,844**	**$133,193**	

Wastewater Treatment Plants

Union Sanitary District's wastewater plant treats an annual average flow of 30 mgd. The treatment process uses conventional activated sludge, chlorine disinfection, anaerobic digestion and belt filter presses. Vallejo's wastewater plant treats an annual average flow of 12.4 mgd. The treatment process uses biofilters, aeration basins, both UV and chlorine disinfection, lime stabilization, and belt filter presses. Both facilities pump their effluent to the bay. Table 3 summarizes the energy of each plant.

Table 3. Energy Summary for Wastewater Treatment Plants

	USD	Vallejo
Plant Flow	10,975 Mgal	4,526 Mgal
Average Daily Flow	30 mgd	12.4 mgd
Total Electricity Cost	$1,007,422 (5.54¢/kWh)	$600,244 (5.7¢/kWh)
Total Identified Savings	$338,540 (33%)	93,900 (15.6%)
Unit Energy Consumption	1,657 kWh/Mgal	2,263 kWh/Mgal
Annual Energy Consumption	18,184,050 kWh	10,243,206 kWh
Cogenerated Power	1,551,561 kWh	Ø kWh
Billing Demand	2,630 kW – 3,200 kW	1,600 kW - 2,900 kW

The energy conservation measures identified for both facilities are summarized in Table 4. Twelve ECMs were recommended for implementation. The ECMs include two lighting retrofits to reduce lighting and improve control, two energy management systems, operational changes to two processes, modifications to two non-potable water systems to reduce load, equipment modifications to improve efficiency, load shedding during peak hours, changes to a cogeneration

system, and a change to a discharge permit to lower demand. The ECMs identified could result in a reduction of over 7,281,000 kWh annually, which would save over $432,000.

Table 4. Summary of ECMs for Wastewater Treatment Plants

Type of ECM	Number	Energy Savings	Annual Cost Savings	Potential Rebates	Estimated Capital Cost	Recommended
Lighting Retrofits	2	10 kW 135,300 kWh	$8,640	$14,884	$20,000	YES
Energy Management System	2	320 – 380 kW 0 kWh	$25,400		$40,000	YES
Operational Changes	2	75 kW 803,000 kWh	$44,800	$35,640	$30,000	YES
Modify NPW System	2	19 kW 762,120 kWh	$42,000	$91,090	$42,000	YES
Equipment Modifications	1	41 kW 29,930 kWh	$1,700	$2,693	$1,000	YES
Load Shedding	1	75 kW 58,500 kWh	$4,900	$5,265	$0	YES
Cogen Changes	1	600 kW 4,600,000 kWh	$254,000	$180,000	$205,000	YES
Permit Changes	1	127 kW 893,500 kWh	$51,000	$80,415	$150,000	YES
Total of Recommended ECMs			**$432,440**	**$409,987**	**$488,000**	

CONCLUSIONS & RECOMMENDATIONS

Conclusion

This project has shown energy assessments to be an effective way to reduce electrical demand and costs at municipal water and wastewater facilities. Several opportunities exist at water and wastewater facilities that could result in further reduction in the state's electrical demand.

Commercialization Potential

No products were developed as a result of this work. The goal of an energy assessment is to reduce electrical consumption and operating costs. Energy assessments range in cost from approximately $10,000 to $50,000 per facility. The assessments typically identify three to five times the cost in annual energy savings.

Recommendations

It is recommended to implement the ECMs identified in this project and to conduct new studies at other facilities throughout the state to further reduce electrical demand and conserve our natural resources.

Benefits to California

The State of California benefits by the conservation of natural resources, reduction in pollution, minimized costs, and improved quality of treatment, which thereby protects the environment.

ABBREVIATIONS

ECM	Energy Conservation Measure
EPRI	Electric Power Research Institute
EPRI-MWW	Electric Power Research Institute Municipal Water and Wastewater Program
HVAC	Heating, Ventilation, & Air Conditioning
kW	kilo-Watt
kWh	kilo-Watt-hour
Mgd	Million Gallons Per Day
MWD	Metropolitan Water District
NPW	Non-Potable Water

EPRI Perspective

EPRI's Municipal Water and Wastewater Program was created to help member utilities address the energy needs of the more than 60,000 water systems and 15,000 wastewater systems in the United States. Theses facilities are among the country's largest energy consumers, requiring an estimated 75 billion kWh nationally, about 3% of the annual U.S. electricity use.

Interest Categories

E3003 Waste & Water Management

L3004 Municipal Water & Wastewater